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Systems Group Chairman

National Transportation Safety Board
Investigations Into Trans World Airlines Flight 800



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Presentation Objective

Describe the research for the ignition
source of a fuel tank in TWA Flight 800 and
our findings



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Two Events Needed for Ignition

1. Energy Enters Fuel Tank
2. Energy is Released Inside Fuel Tank



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All Potential Sources Were Considered:

- Main Landing Gear & Wheel Well Fires or Explosions
- Fuel Pump Failures
- Uncontained Engine Failure
- Vent System Fires
- Auto-ignition or Hot-surface Ignition



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Potential Sources, continued

- Fuel Quantity Indicating System (FQIS)
- Static Electricity / Lightning
- Small Explosive Charges
- Missile Fragments
- Meteorite Strikes



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Scavenge Fuel Pump

- No Evidence of Use On CVR
- Switch Found in “Off” Position
- Testing Contained Flames Inside of Pumps



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Static Electricity

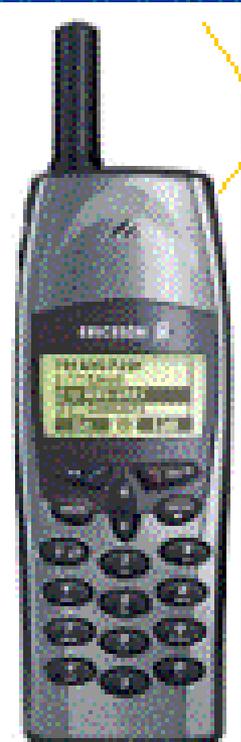
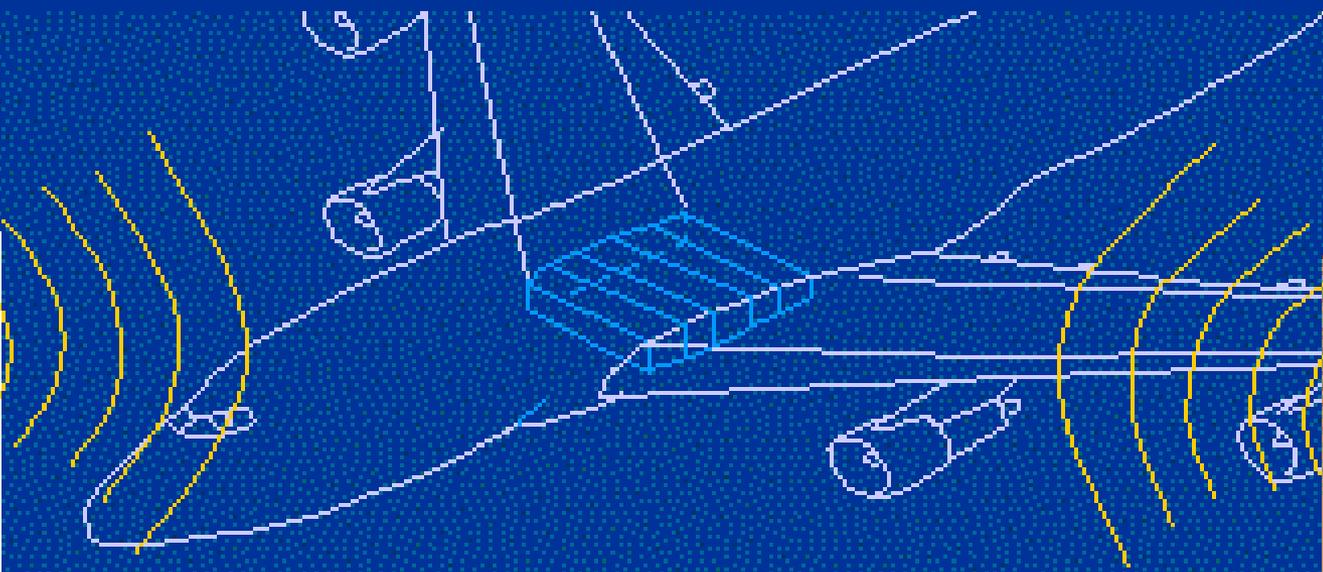
Testing Was Unable To Achieve Ignition
Energy With Conditions Believed To Exist



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Electromagnetic Energy



- Electromagnetic Energy Sources Did Not Reach Minimum Ignition Energy





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Non-FQIS potential ignition sources
considered unlikely.

Electrical malfunction involving FQIS
examined.



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What Is The FQIS*?

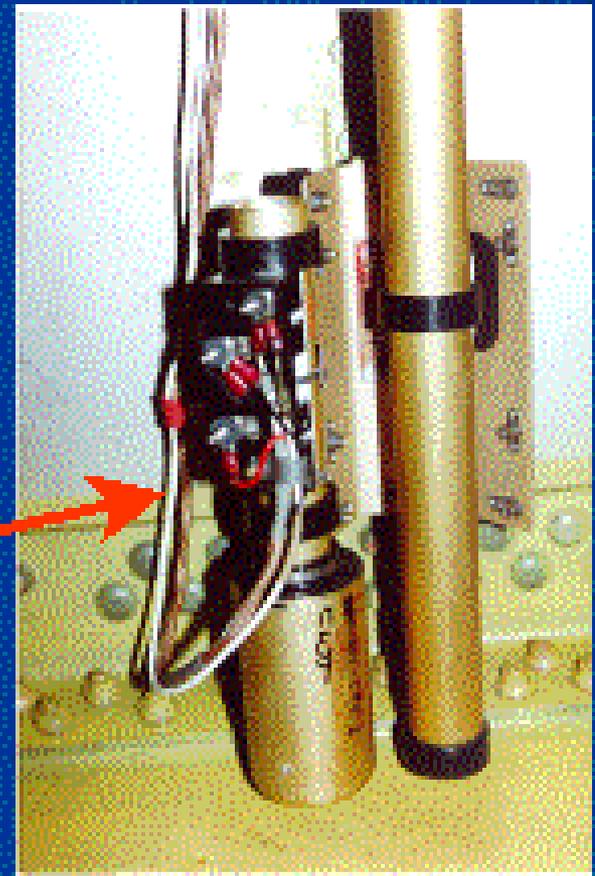
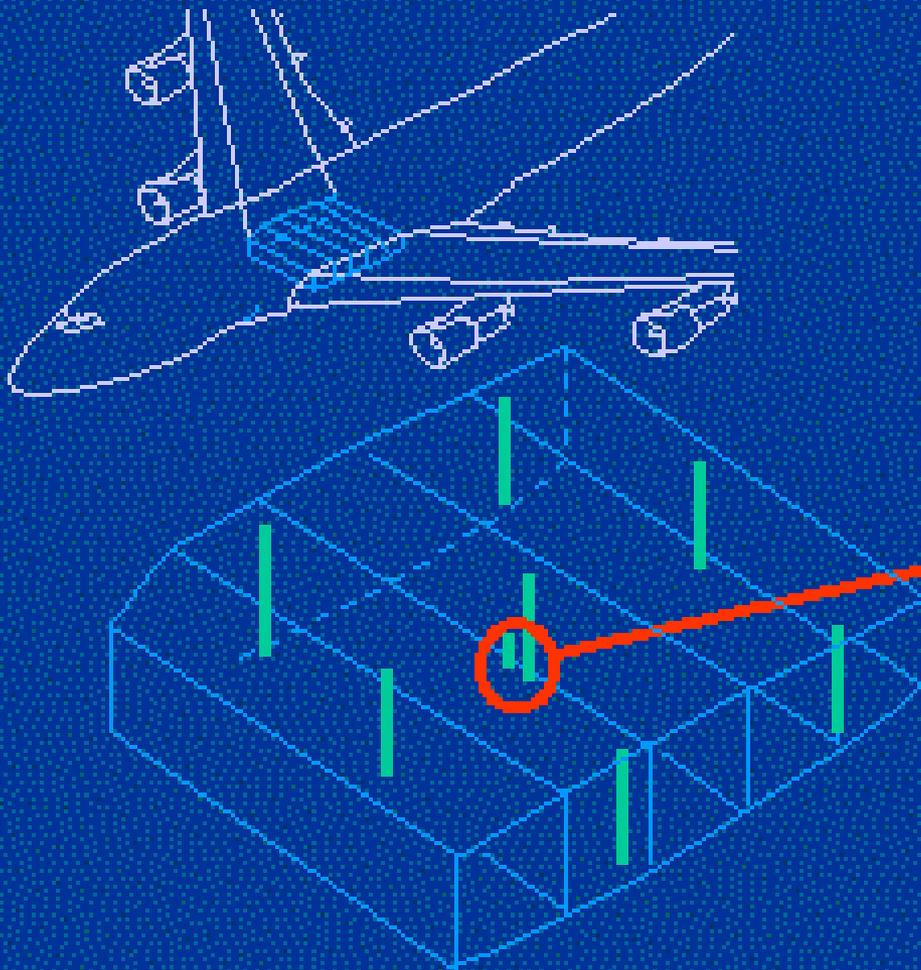


PHOTO OF COMPENSATOR
AT BASE OF PROBE

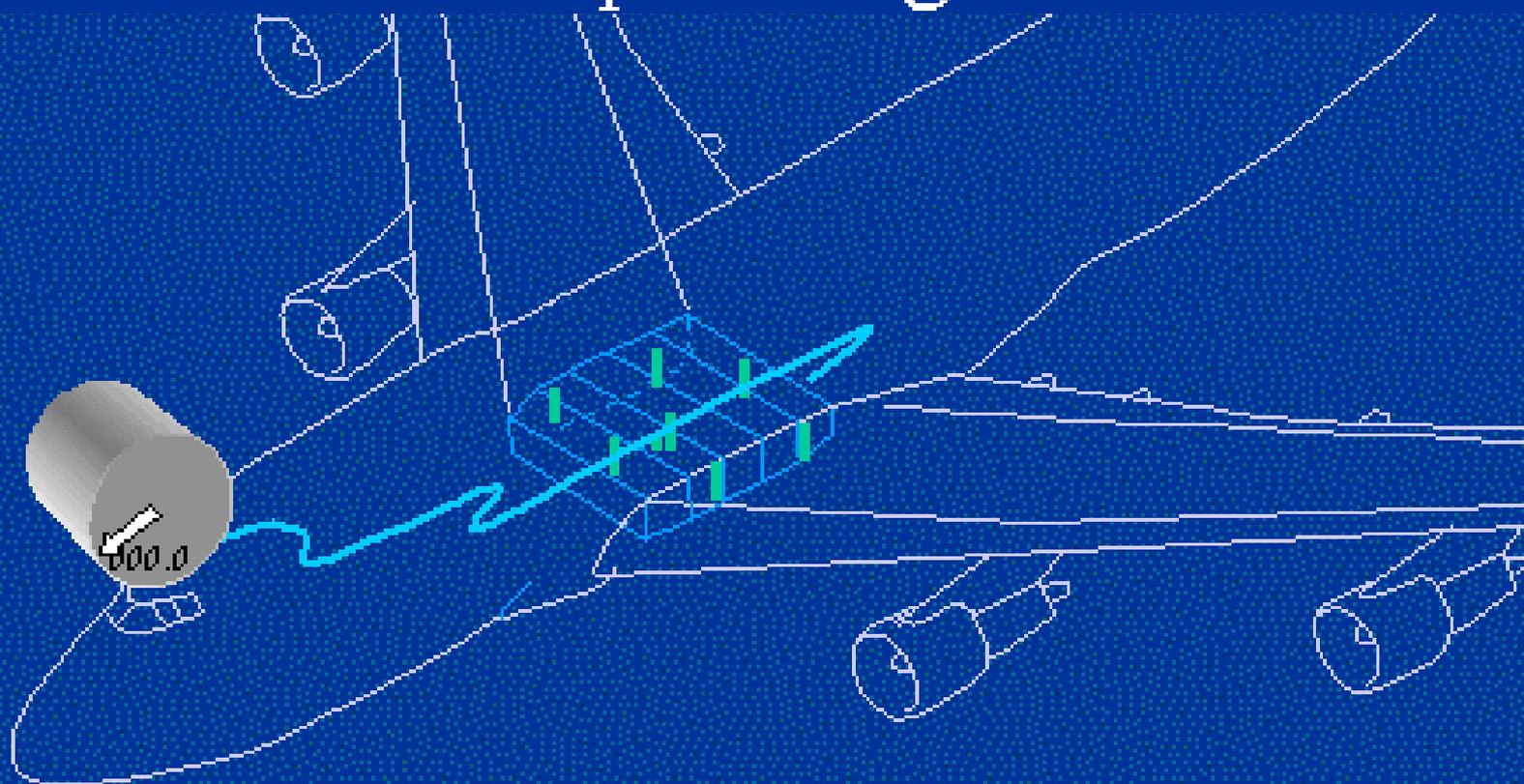
*FQIS = Fuel Quantity Indication System



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Wires Connect The Probes To A Cockpit Gauge



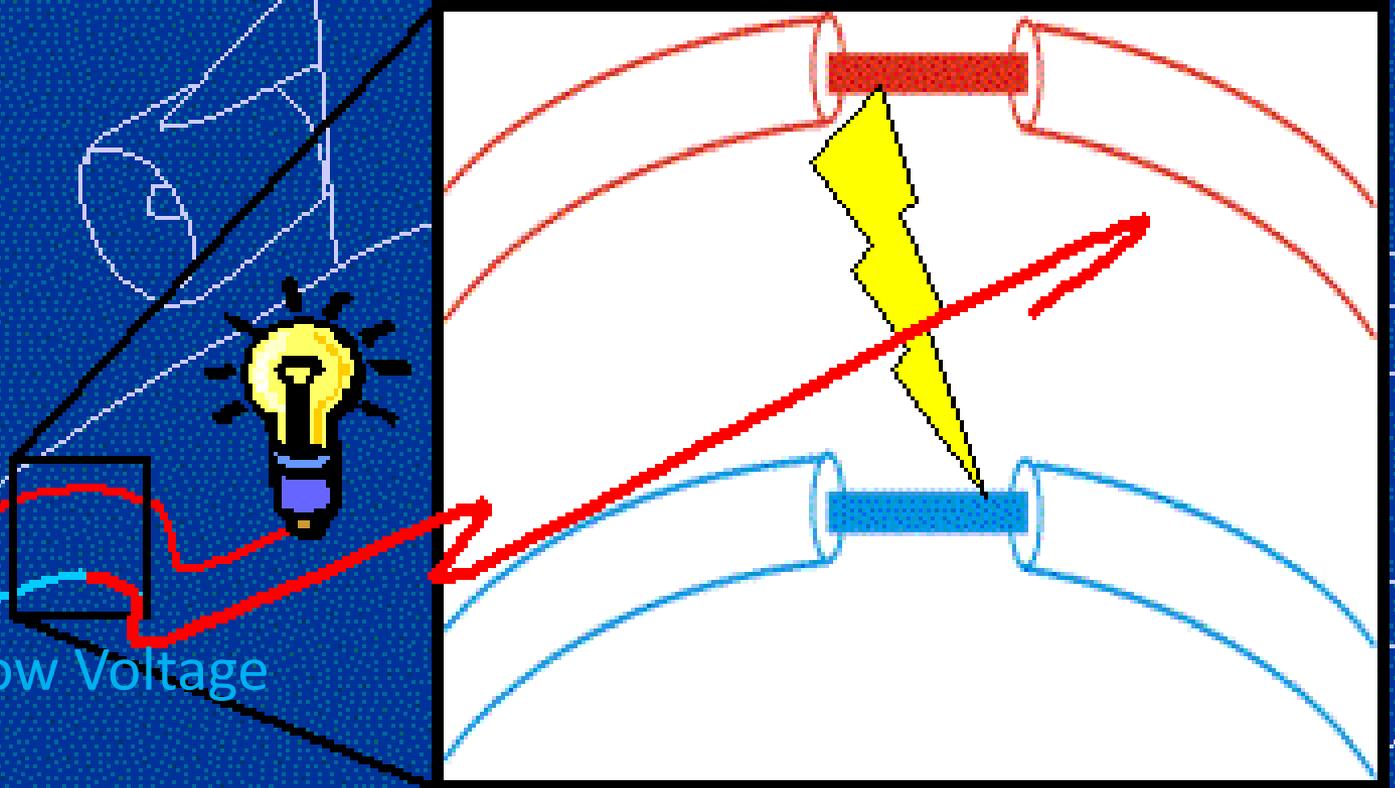


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High Voltage

Low Voltage

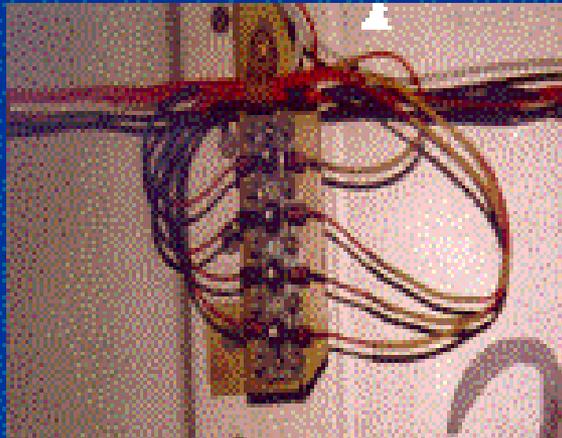
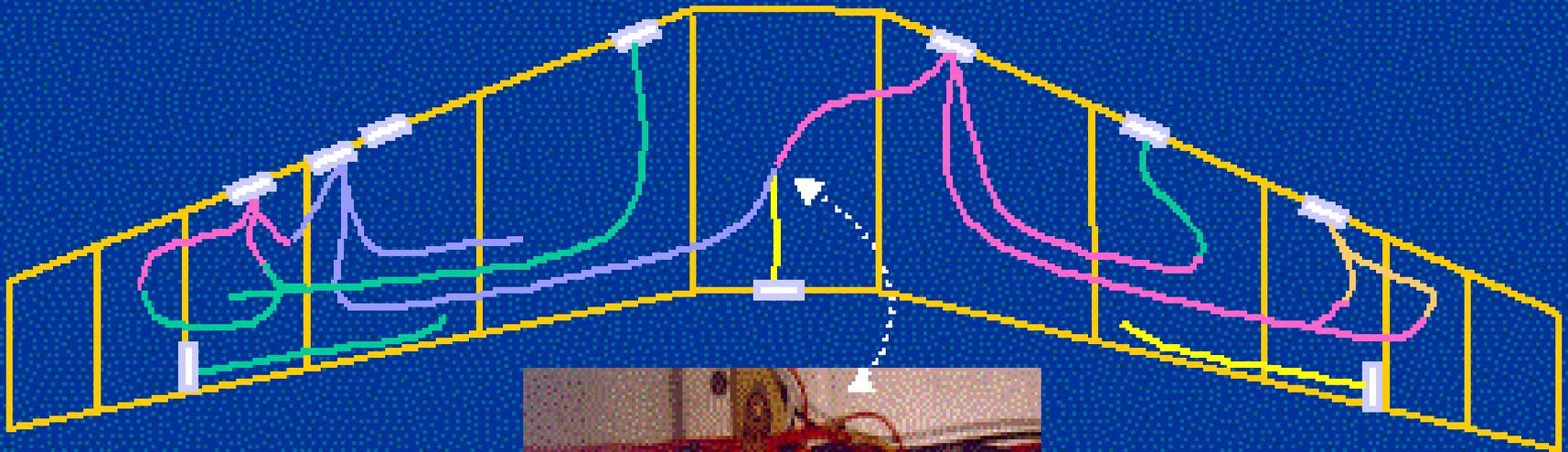




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Wires Connect Fuel Tanks



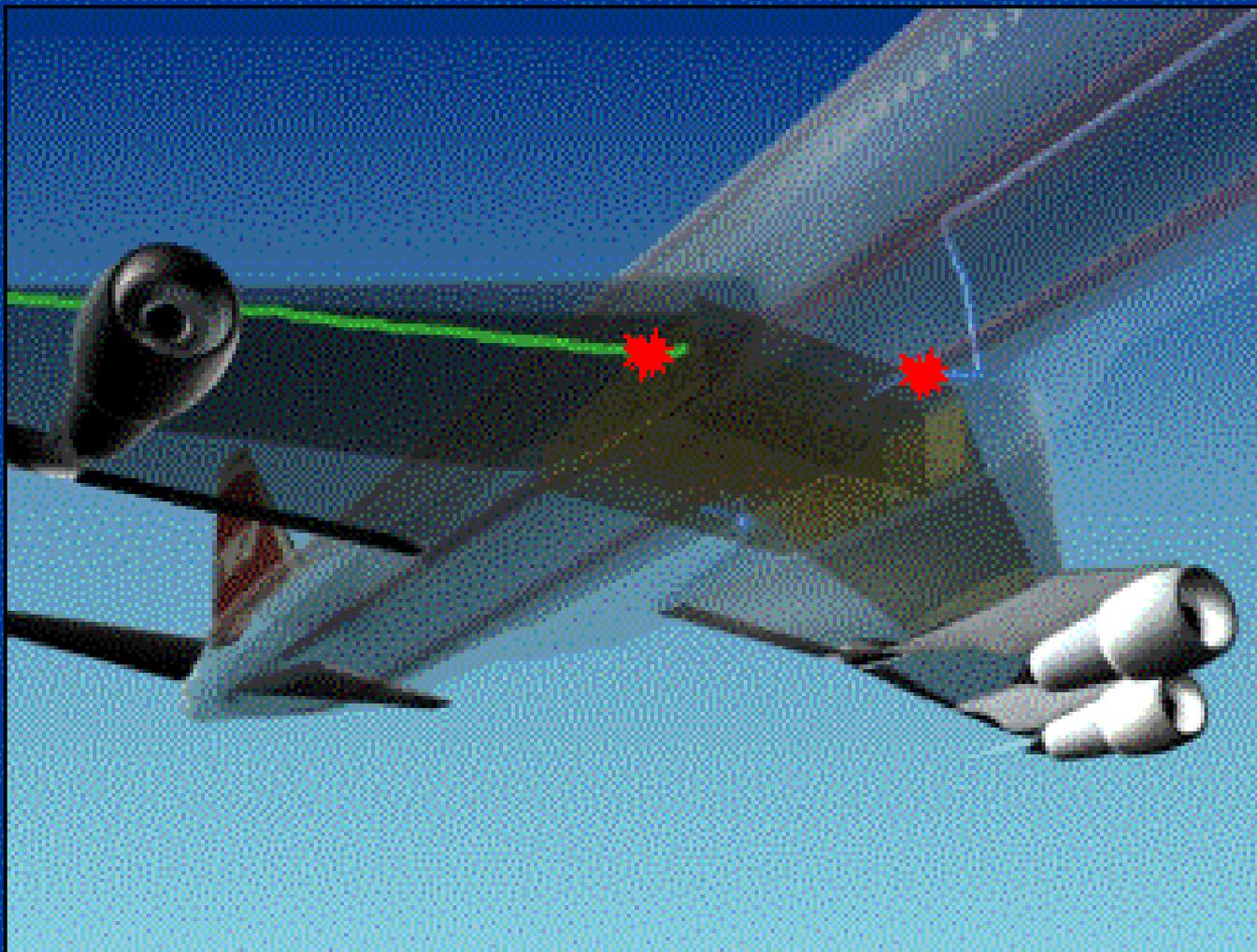
CENTER TANK TERMINAL STRIP (TYPICAL 747)



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Locations Of Short-Circuit Events

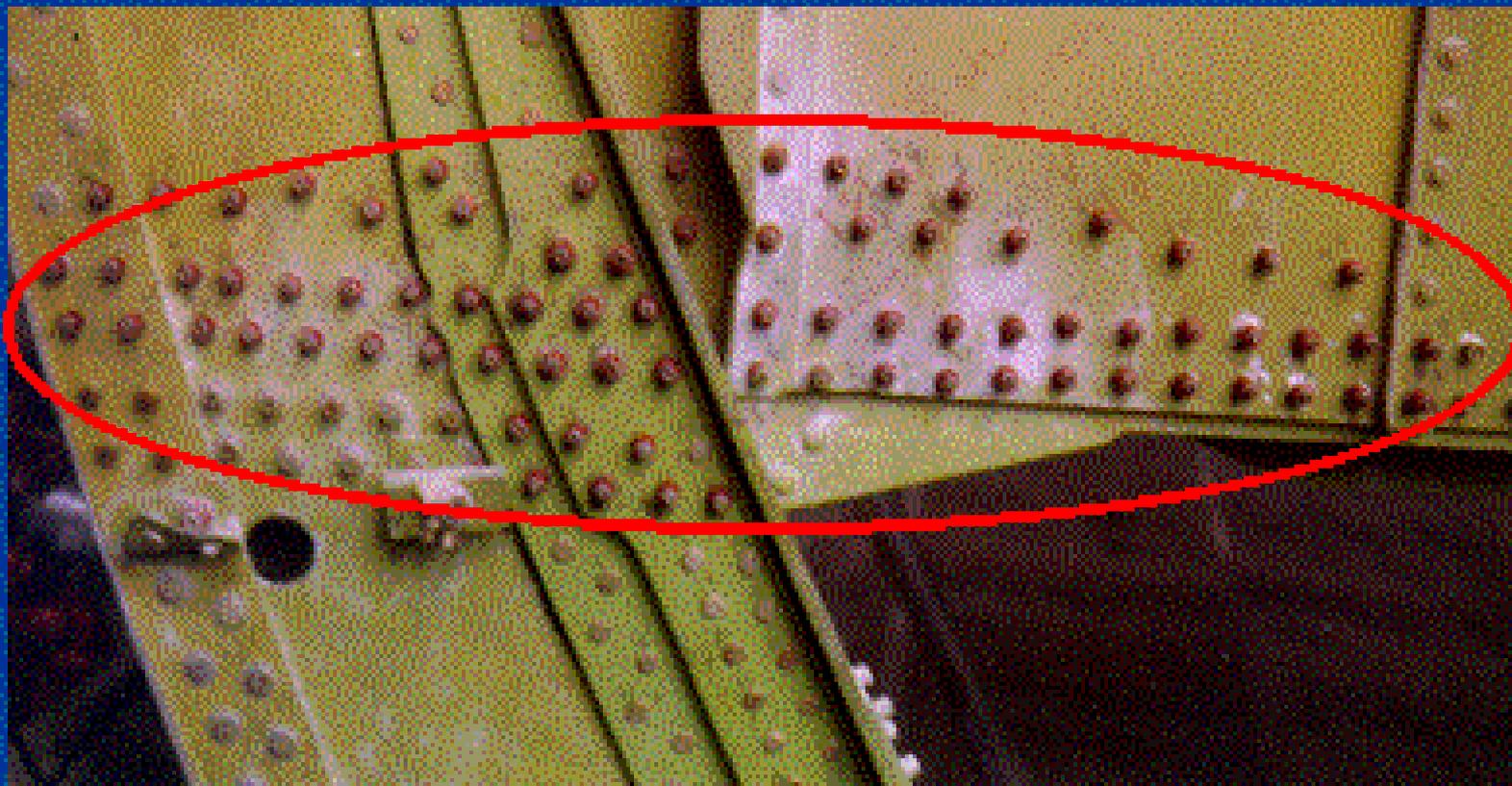




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Repairs Were Found Along Routes of FQIS, Fuel Flow, and Lighting Wires



Riveted structure added in TWA 800 avionics compartment



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Short Circuit Tests – Drill Shavings

SHAVING IN WIRE BUNDLE



- Shavings Cut through some Wire Insulation
- Other Shavings were Shed by Insulation
- Shavings Could Transfer Energy

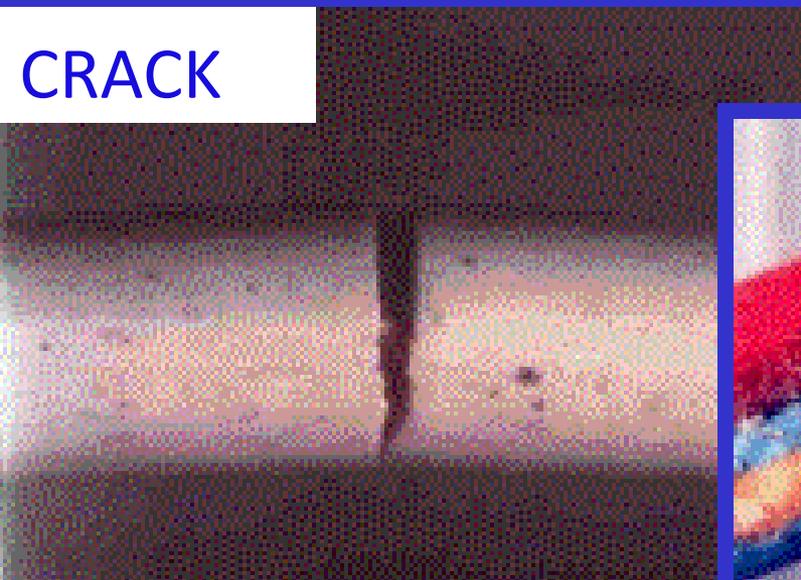




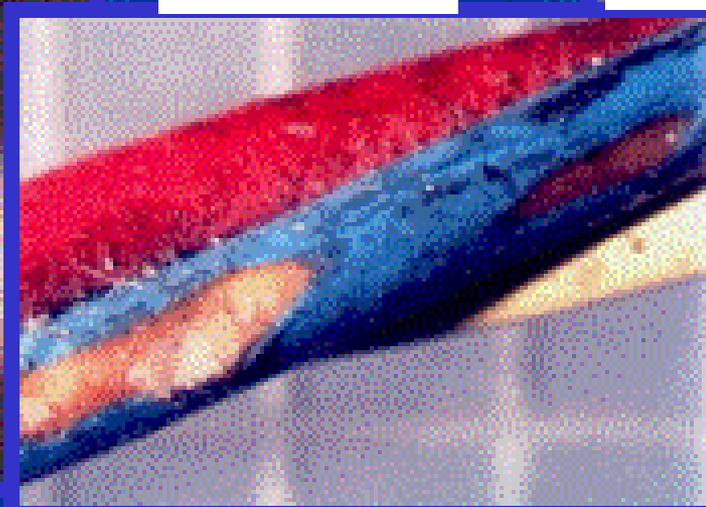
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Damaged Wire Found In TWA 800 Wreckage Led To Finding Wire Damage In Other Airplanes



CRACK



CHAFE



GOUGE

Photographs of 747 and DC-10 wires submitted by NTSB to laboratory at Raytheon Corporation

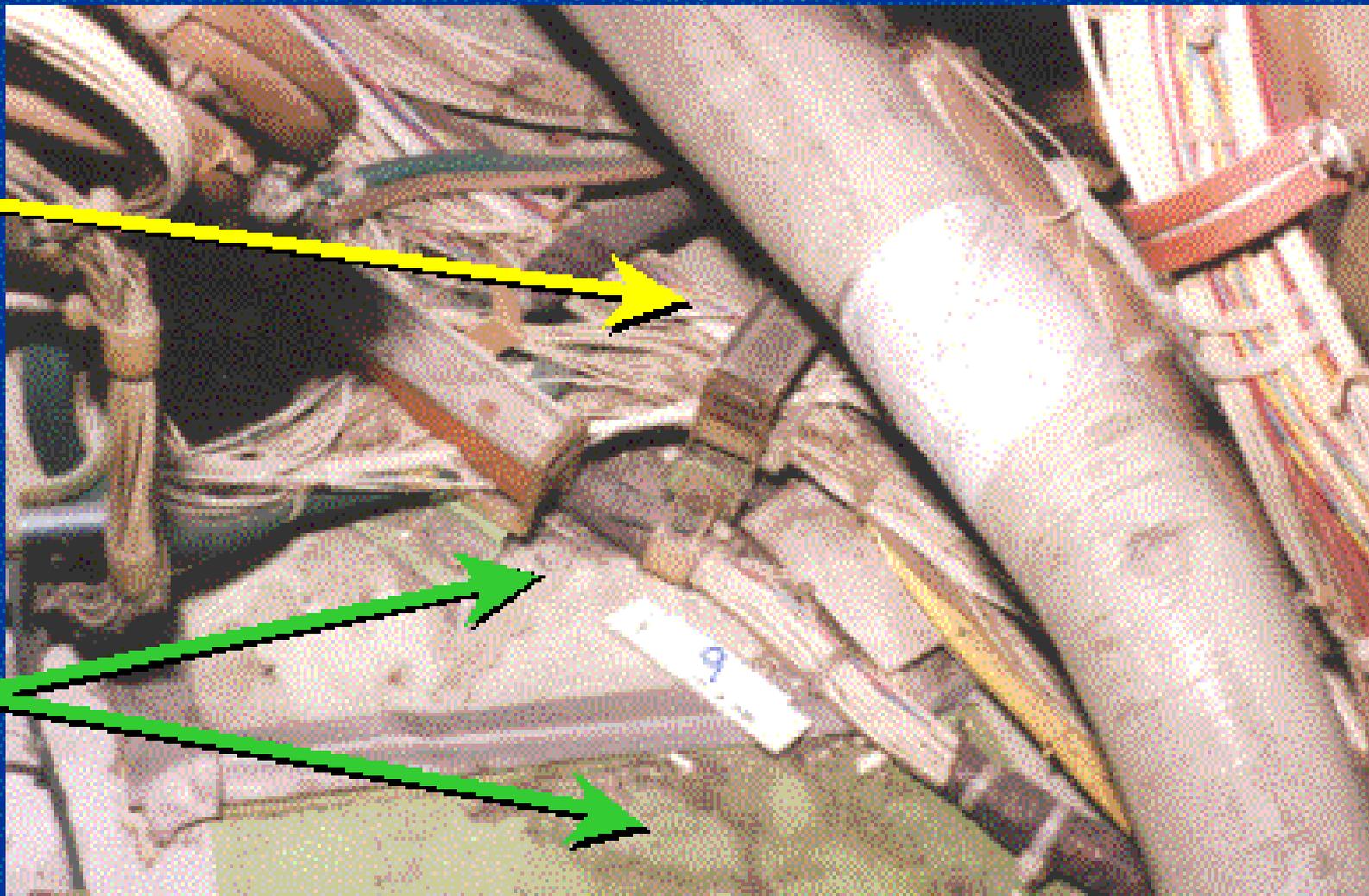


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Fluid Stains

Fuel
Gauge
Wires



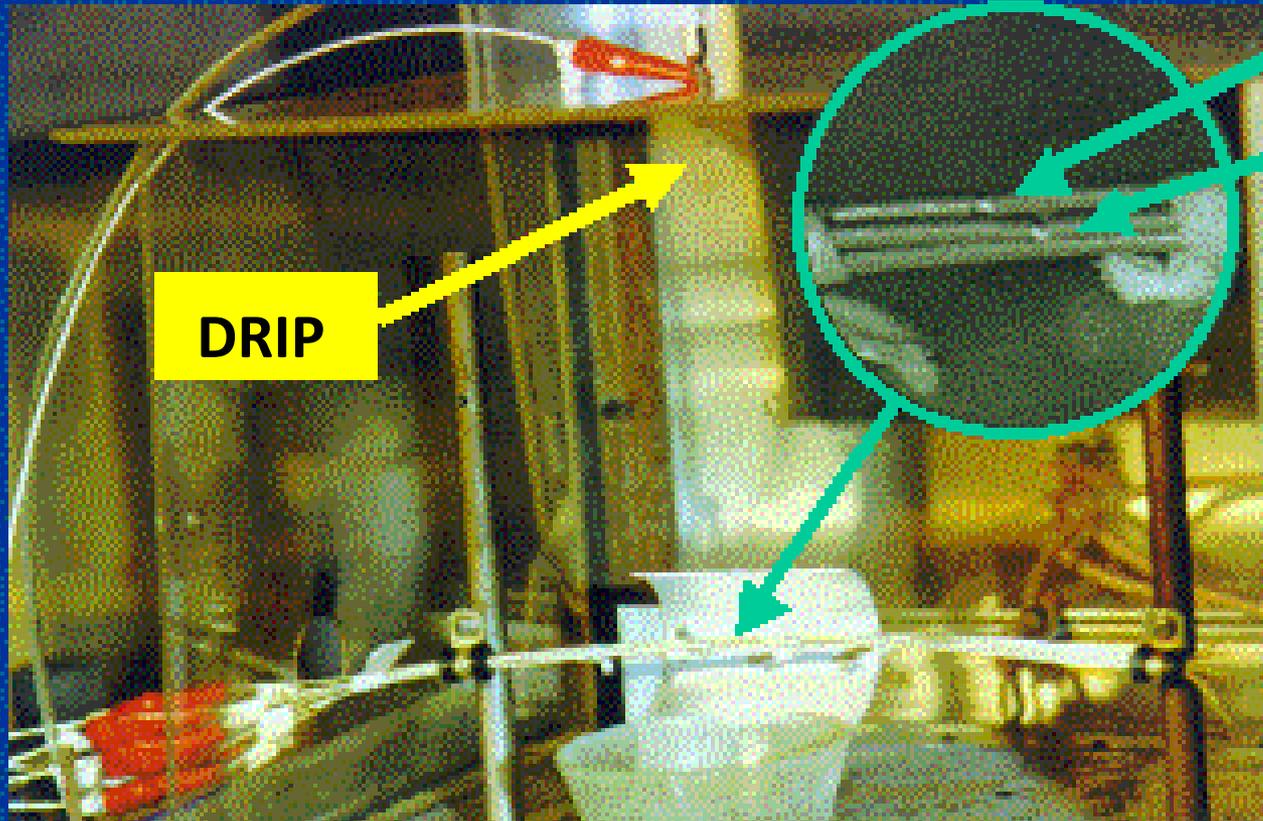
Fluid
Stains



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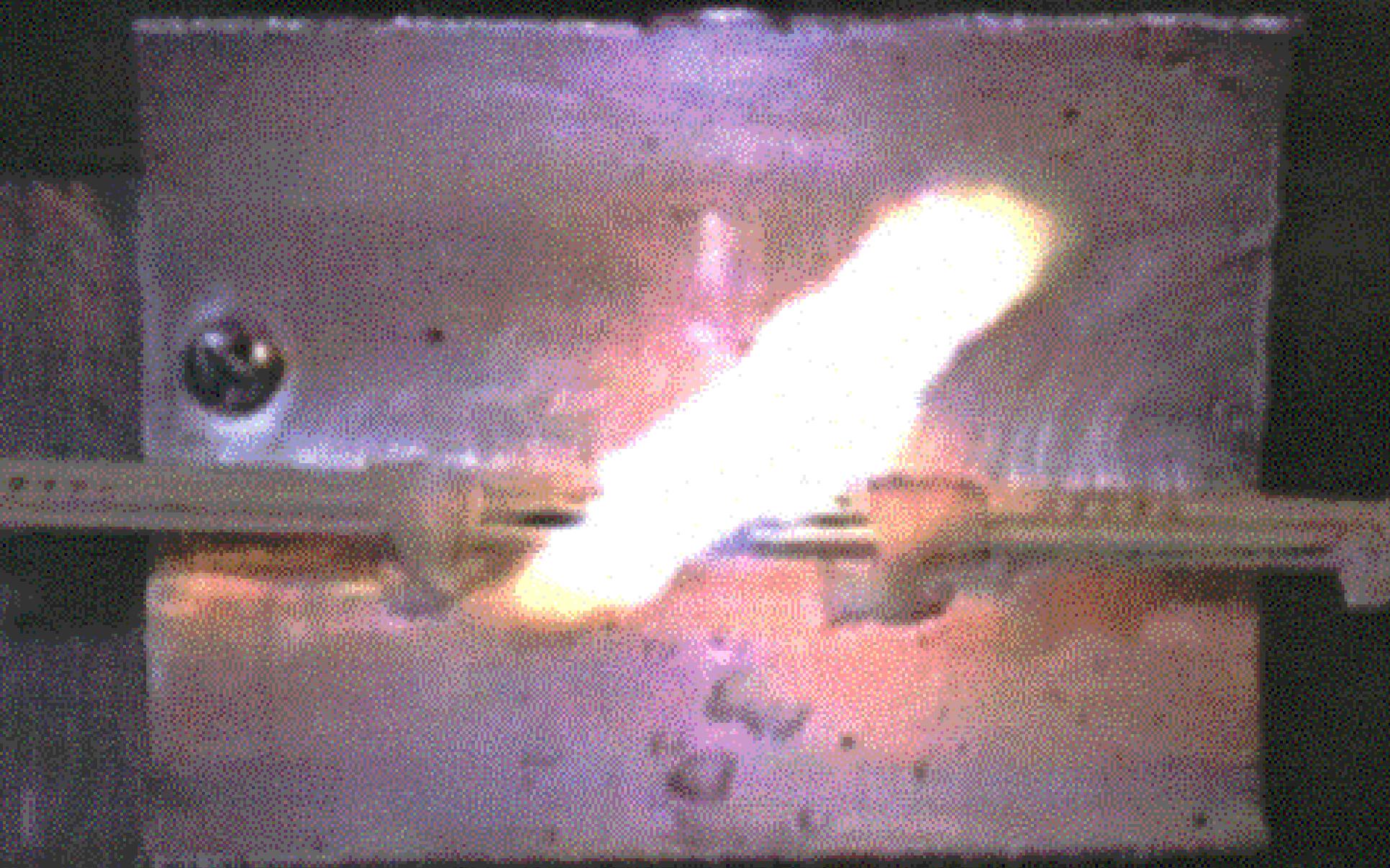
Wet-Arc Test Set-Up



Cut
Wires In
Bundle

LECTROMECH COMPANY PHOTOGRAPH

Power Found In A Flash





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Evidence of a Wet-short

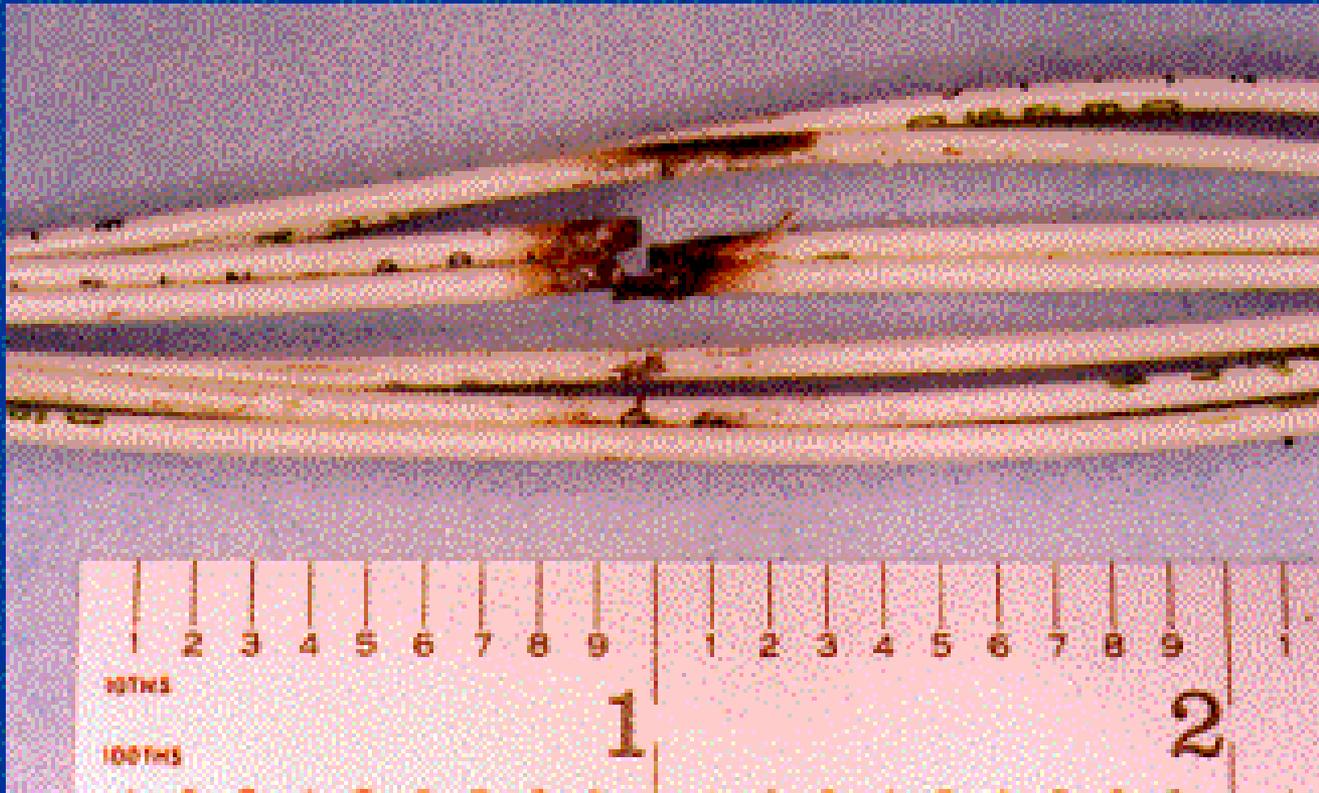


Photo Of Poly-X Wires After % Minutes Of Wet-Short
(Wires From 1970-Era 747)



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Potential Evidence of a Short Circuit in TWA 800

Comment about fuel flow indication,
Drop-outs in CVR background noise,
Fuel gauge indication more than double at JFK,
Lighting and refueling discrepancies in weeks
before accident.



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Two Events Needed for Ignition

1. Energy Enters Fuel Tank Through Wires
2. Energy is Released Inside of the Tank



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Little Wiring Was Recovered From TWA 800 CWT



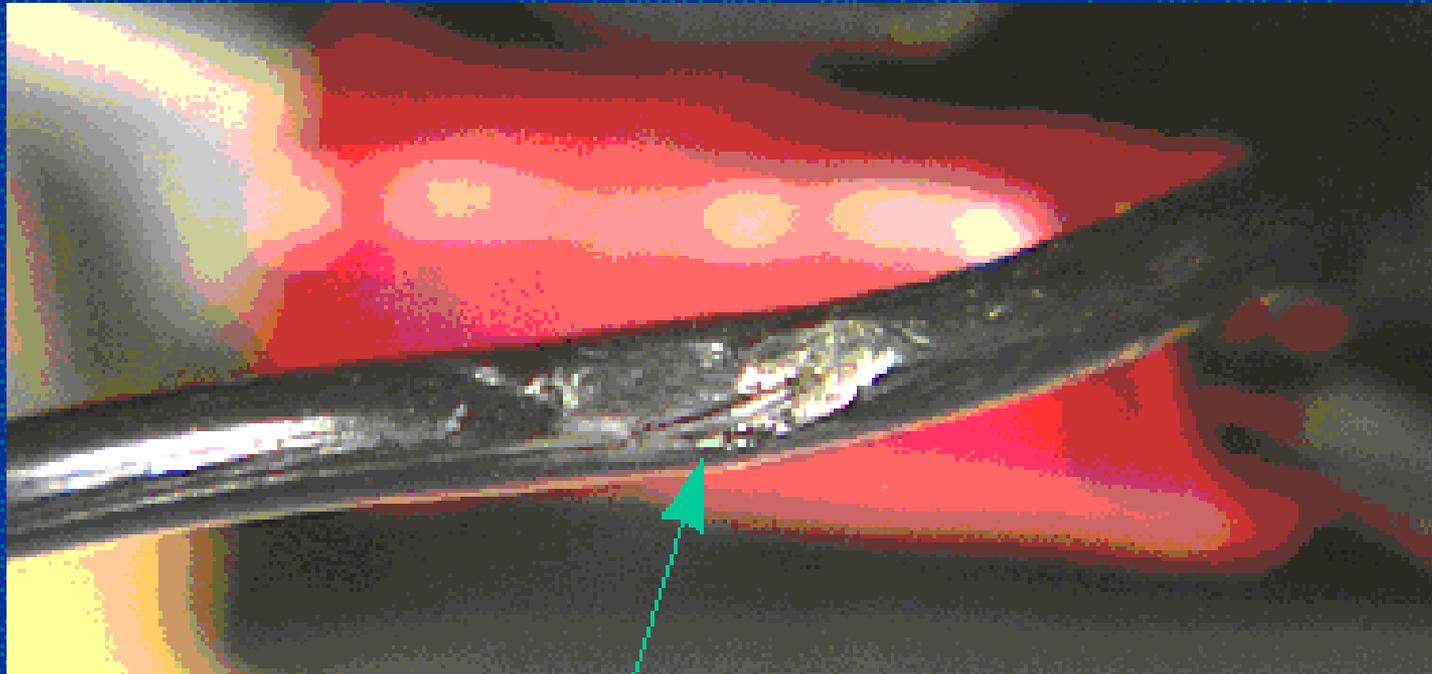
Photograph shows TWA 800 CWT spar connector and most of the wiring recovered from CWT



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Release Of Energy In CWT By Arcing or Filament Heating



Photograph of exposed copper in 747 fuel tank wire

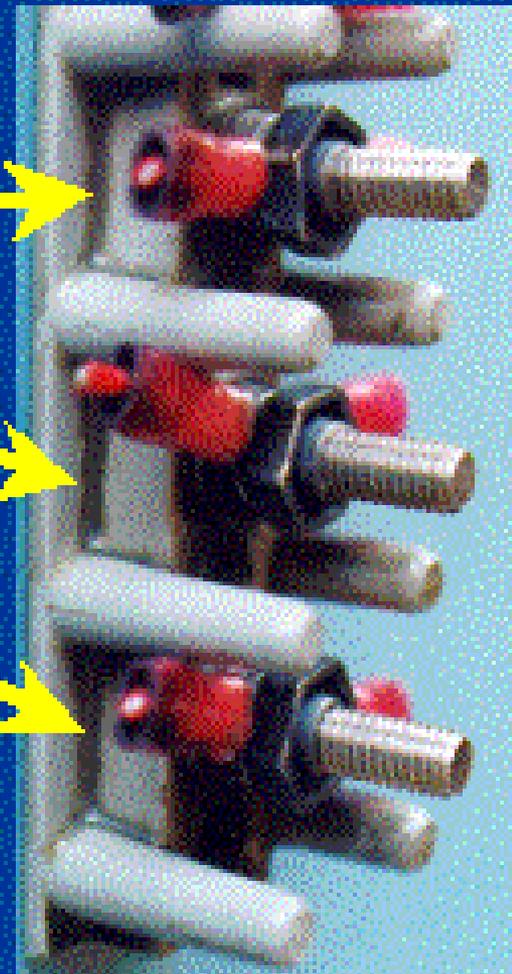
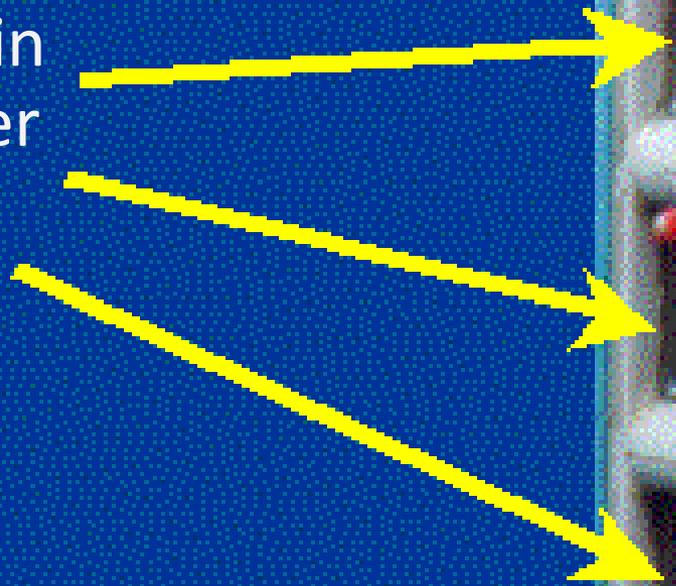


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Release Of Energy In CWT Through Sulfide Deposits

Deposits found in
TWA 800 & other
747s, as seen in
corners



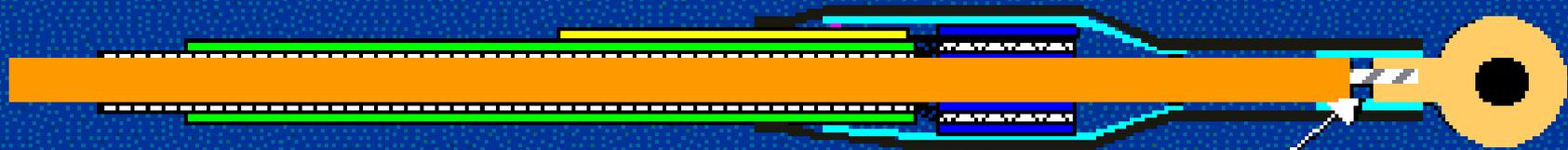
Terminal strip from 747 CWT that had malfunctioning fuel gauges.



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Sulfidation Remediation Developed

No Silver Exposed to Fuel



Nickel plated wire
Gold plated connector



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Review

Two Events Needed for Ignition Through Fuel Gauge Wires

1. Energy Enters Fuel Gauge Wires at Short Circuit Outside of Tank
2. Energy is Released Inside of the Tank



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Summary

The most likely ignition event was a short circuit outside of the center wing fuel tank that entered the tank through electrical wiring associated with the fuel quantity indication system.



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